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ABSTRACT

Three main issues relating to the question of silent speech in reading are considered: (1) How do Chinese speakers process Chinese ideographs in short-term memory? (2) How is Chinese students' learning of written English affected by the transition to an alphabetic language? (3) Are the strategies for encoding written words in short-term memory different for students of diverse language backgrounds? Chinese and Spanish bilingual students were tested for short-term memory encoding strategies on word-recognition tests. Chinese speakers were found to encode Chinese ideographs phonologically, but both Chinese and Spanish learners of English were found to encode English words visually. Implications for the acquisition of reading are discussed in terms of a two-stage model. (Author/CFM)

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Even Chinese Ideographs Are Phonologically Encoded in Short-Term Memory

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Running Head: Chinese Ideographs in Short-Term Memory

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Even Chinese Ideographs Are Phonologically Encoded in Short-Term Memory

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Donald J. Loritz

Subject Index

Reading

Ideographic v. alphabetic

Short-term memory

Phonological v. visual coding

Language acquisition

First and second language reading

Abstract

Three main issues relating to the question of silent speech in reading are addressed: 1) How do Chinese speakers process Chinese ideographs in short-term memory? 2) How is Chinese students' learning of written English affected by the transition to an alphabetic language? 3) Are the strategies for encoding written words in short-term memory different for students of diverse language background ? Chinese and Spanish bilingual students were tested for short-term memory encoding strategies on word-recognition tests. Chinese speakers were found to encode Chinese ideographs phonologically, but both Chinese and Spanish learners of English were found to encode English word visually. Implications for the acquisition of reading are discussed in terms of a two-stage model.

A number of studies have shown that when verbal items (English words, consonants) are visually presented to groups of adults for immediate recall, or recall delayed by several seconds, the material is encoded in phonological form (Baddeley, 1966; Hintzmann, 1967; Murray, 1966; Sperling, 1963; Wickelgren, 1965). Conrad (1964) found that visually presented items were encoded in short-term memory in the same way as items presented auditorily through white noise. The correlation between the error matrices for these two modes of presentation was significant beyond $p<.001$. The possibility that these matrices were based upon a visual encoding strategy can be excluded by comparing them with Thomasson's shape-confusion matrices (Conrad, 1972a).

Baddeley (1966) auditorily presented subjects with a list of eight acoustically similar words and a list of 12 acoustically dissimilar control words. A different group of subjects was given semantically similar words and dissimilar words. The results showed that the acoustically similar word list was harder to recall accurately than the semantically similar list. In this experiment, however, the acoustically similar words also looked alike (e.g. mad, mat, man, cap, cad). Therefore, in a second experiment subjects were given words which were acoustically similar but dissimilar in form. Again, acoustically similar words were significantly harder to recall accurately than control words. In a third experiment, words drawn from 10 acoustically similar items

and a set of control words were visually presented. Eight of the acoustically similar words were the same as those used in the first experiment, i.e. they were similar in shape as well as sound. Although the results were in the same direction as in the auditory experiment, the shape factor again was not controlled.

Several additional experiments have been carried out in which subjects were required to vocalize something other than the visually presented item. This seriously impaired recall (Conrad, 1963, 1965; Murray, 1967, 1968).

Conrad (1971) addressed the question of the form of storage for children. He presented two sets of pictures to children with mental ages of three to 11 years. One set of pictures depicted words which Conrad termed "homophones"--rat, bat, hat, cat, mat, man, bag, tap--the (H) set. The other set was designated the "non-homophone" (N-H) set and consisted of girl, bus, train, spoon, fish, horse, clock, hand. The experimenter named each card in a set and then turned it over. The children were asked to match from a complete duplicate set those cards they had just seen. It was found that up to the age of five there was no difference between the recall of H and N-H sets. Beyond five, however, there was a consistently increasing advantage for the N-H set as the older children confused the like-sounding members of the H set in recall. In this experiment, the experimenter named each picture aloud upon presentation, and, hence, the stimulus was presented both visually and auditorily.

The younger children nevertheless stored the picture set in the form of visual images. The older children, on the other hand, had progressed to using phonological representation in short-term memory. Conrad concluded that children begin with a visual representation for recall and then, as they mature, a phonological representation comes to be used. Conrad (1972) states in his conclusion that:

> "Silent speech in reading is near universal in cultures where alphabets are used." (p.236)

The present study addresses the question of the use of silent speech in reading in a culture in which an alphabet is not used. English orthography is more closely related to sound than is Chinese. On the other hand, Chinese orthography is more closely related to meaning than is English. This contrast might form a a basis for Conrad's restriction of silent speech in reading to alphabetic cultures. However, little research has been done on the processes involved in the acquisition of ideographic reading.

Van Yen Yin and Zian Chi Tsen (1962) studied a group of Chinese monolingual first-graders in a Shanghai primary school. The first-graders were just being introduced to the written Chinese characters. Van and Zian proposed a three-stage model for the Chinese first-graders learning the Chinese written form. In the first stage, children relate previously learned sound/meaning associations with only the global shape of the written characters. In the second stage they associate sound/meaning with parts of

words and often wrongly substitute parts from similar characters. Finally they are able to make the correct association between sound/meaning and the correct strokes. It was found that the errors made by the first-graders in a dictation-recall test were due mainly to shape and the mastery of strokes within each character. There were some confusions with semantically and phonologically similar words, but the percentages were small (8% and 13% respectively). It seems that at this initial stage, Chinese children rely on a visual strategy to master the Chinese characters. We are, however, aware of no study of the subsequent strategies used by Chinese children, nor are we aware of any study which has explored the acquisition of alphabetic reading by Chinese bilinguals.

The present study therefore addresses three basic questions concerning the mode of short-term memory storage of written material by Chinese speakers. First, how do mature Chinese speakers encode ideographic writing in short-term memory? Second, how do Chinese speakers who are learning English as a second language encode its alphabetic representation in short-term memory? Third, does the Chinese learners' encoding of English words differ from that of other learners of English whose native language is alphabetic such as the Spanish speakers?

Method

Subjects

Subjects were 22 Cantonese-speaking Chinese students. Sixteen

Spanish-speaking students served as the comparison group. All subjects were enrolled in transitional high-school bilingual programs. Ages ranged from 16 to 20 years.

Materials

The Chinese Word Recognition Test consisted of 15 stimulus and response lists. Each stimulus item contained six unrelated Chinese characters hand-printed across the page. Thus there was a total of 90 stimulus characters. Each stimulus item was photographed and mounted on a slide. Each response item contained seven internally unrelated Chinese characters. Items were hand-printed across the pages of a response booklet, one item per page. Of the 105 response characters, 45 were "correct responses", i.e. the same character as shown in the stimulus slide; 15 were "phonological distractors" (Cantonese homonyms), 15 were "semantic distractors" (Cantonese synonyms), 15 were "visual distractors" (Cantonese homographs) and 15 were "random responses" which were neither phonologically, visually nor semantically similar to the stimulus items (see Appendix 1). List-positions of words were randomly assigned (see Appendix 2).

The English Word Recognition Test contained materials similar to those of the Chinese Recognition Test, except that there were 18 items. Each item contained four internally unrelated English words in the stimulus set, and five corresponding words in the answer booklet. A serifless Vari-Type type face (style V3652)

was used to maximize the confusability of the English words. Of the total of 72 words, 36 were "correct responses", and the rest were equal numbers of phonological, visual and semantic distractors. (See Appendix 3 for lists of pairs of stimulus and distractor words. The randomized lists of words are given in Appendix 4.)

The words in both tests were carefully selected so as to maximize the similarity within one category only and minimize the possibility of being classified according to another category. For example, "hall/bail" were a stimulus-response pair for visual similarity and were unlikely to be confused either phonologically or semantically. Hence if a subject responded to "hall" with selection of "bail" we could safely assume he was using a visual strategy in short-term memory. All the phonological distractors for the Chinese Recognition Test were homonyms. While it was harder to find as many homonyms for English, no phonological stimulus-distractor pair differed by more than one distinctive feature.

For both tests, each stimulus item was shown for four seconds and the subjects were allowed 11 seconds to respond. The number of words in each item and the presentation time was determined by pre-testing in a pilot study.

The Chinese Recognition Test was given first, so that subjects would become familiar with the procedures. The instructions were

given orally in Cantonese for the Chinese Recognition Test and, with appropriate changes, in English for the English Recognition Test. The English instructions were as follows:

> This is a language memory test. We will show you a series of slides. Every slide has four English words. You have four seconds to remember them. Turn to the next page when the words disappear from the screen. We want to see how many words you can remember. Circle as many as you can remember. Now we have a practice item . . .

The subjects were given two practice items. A synchronized tape-recorder and slide projector system was used for controlling presentation times. Stimuli were projected onto a 1.8m X 1.8m screen. The English Recognition Test followed the Chinese Recognition Test. The English Recognition Test was later administered to the Spanish control subjects using the same procedure. A Spanish bilingual teacher from the school translated the instructions into Spanish.

Results

The percentage of error-types made by the subjects are given in Table 1.

Insert Table 1 about here

For the Chinese subjects, 34.7% of the errors on the Chinese

Recognition Test were visual as compared to 51.9% phonological errors. On the English Recognition Test, they made 58.1% visual errors as against 22.5% phonological errors. The Spanish subjects also made a greater number of visual errors at 51.0% as against 30.6% phonological errors. Two kinds of patterns clearly emerged. The Chinese subjects' responses on the Chinese Recognition Test indicated that the word recognition strategy in the first language was predominantly phonological. However, on the English Recognition Test, both the Chinese and the Spanish subjects showed an opposite, predominantly visual, strategy in the second language. T-tests were performed for the three categories of errors comparing the Chinese and the Spanish group on the English Recognition Test. None of these was significant ($t < .898$ for semantic responses, $t < .189$ for visual responses and $t < 1.114$ for phonological responses).

One-way analysis of variance showed that within each of the three test administrations there were significant differences among the types of errors made. The Tukey method of multiple comparisons was then used to evaluate the significance of difference in the number of phonological, semantic and visual errors made under each condition. These results are given in Table 2.

Insert Table 2 about here

As shown in Table 2, the visual and phonological strategies

were significantly more important than the semantic strategy. In their native ideographic language, Chinese subjects showed a significantly predominant phonological strategy ($p < .005$). However, in English, they showed a significantly predominant visual strategy ($p < .005$). While the Spanish subjects also showed a greater visual error rate on the English text, the contrast with the phonological error rate failed to reach significance.

Discussion

The results of this study extend Conrad's statement concerning the use of silent speech in reading to the processing of non-alphabetic languages. Our finding that adult native Chinese speakers process Chinese words phonologically has been further supported in a recent study by So and Potter (note 1). In a reaction time study, they found that the naming of Chinese characters was faster than either the naming of pictures or English words. They conclude that there is an internal phonological representation of characters which is readily available to Chinese speakers. It seems likely, therefore, that phonological representation of words in short-term memory is universal for proficient reader in their first language. It should be recalled that there is evidence that both Chinese and English children begin learning to read using a visual strategy (Conrad, 1971; Van & Zian, 1962). We therefore suggest that the development of a mature phonological strategy in first language reading can usefully be discussed in terms of a

two-stage model. Stage 1 corresponds to that time when short-term memory representation of written material is predominantly visual, and stage 2 corresponds to a later time of predominantly phonological short-term memory representation.

Our finding that both Chinese and Spanish learner of written English use a visual strategy leads us to hypothesize that the process of learning to read in a second language follows this first language model. This hypothesis seems tenable since strategies employed in second language are often similar to those used in first language acquisition (Ervin-Tripp, 1974; Cook,1973). This hypothesis might also explain our Chinese subjects' more pronounced visual strategy for English words. The first language strategy for learning to read Chinese may rely more heavily upon a visual shape-meaning association because the shape of Chinese written words has a closer relationship to meaning than does the shape of English or Spanish words. Thus, by transferring their first language strategy, our Chinese subjects may have been progressing toward stage 2 in their second language at a slower rate than our Spanish subjects. Alternatively, our Spanish subjects' background in an alphabetic system may have accelerated their progress toward stage 2 in English. However, while our study lends support to a two stage model for first written language learning, we still have no evidence that progress to stage 2

phonological processing is a possible or necessary prerequisite to proficient reading of a second language. Further research on this issue should be of both theoretical and practical importance.

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Footnotes

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Table 1

Types of Errors Made by Chinese and Spanish Subjects in Word Recognition Tests

Group	Percent of Errors			
	Semantic	Visual	Phonological	F
Chinese Ss[a]				
Chinese RT	7.5	34.7	51.9	36.16**
English RT	11.3	58.1	22.6	13.97**
Spanish Ss[b]				
English RT	16.3	51.0	30.6	4.04*

[a] $n = 22$

[b] $n = 16$

** $p < .001$

* $p < .025$

Table 2

Values of q From Tukey Multiple Comparisons

of the Three Types of Errors

(S = semantic; V = visual; P = phonological)

	Chinese subjects n = 22		Spanish subjects n = 16
Error Type	Chinese RT	English RT	English RT
S x V	7.3875**	7.322**	4.084*
V x P	4.6575**	5.555**	2.4
S x P	12.045**	1.766	1.63

**$p < .005$

* $p < .025$

Appendix 1

Stimulus	Visual distractor	Stimulus	Phonological distractor	Stimulus	Semantic distractor
乖	乘	找	爪	佩	帶
因	困	真	珍	停	止
未	末	狹	洽	先	前
免	兔	教	較	加	增
水	永	今	金	口	嘴
由	甲	巴	爸	住	宿
肚	肝	細	堺	回	歸
計	訃	單	丹	彷	似
閒	間	道	度	喜	樂
力	刀	字	自	替	代
旦	目	九	狗	父	爸
夫	夭	流	留	青	綠
土	士	不	筆	橘	橙
明	朋	避	鼻	走	行
已	己	保	補	兄	哥

Appendix 2

Stimulus Lists

舞	火	戶	困	較	珍
增	居	爸	向	白	未
金	說	松	侵	飛	前
肝	拾	爪	自	驚	止
兵	手	好	堵	嘴	樂
給	兔	赤	之	脚	千
度	甲	訃	心	木	丑
聞	江	人	樹	刀	子
森	風	目	宿	歸	報
悄	似	丹	吹	肉	塗
父	有	震	永	代	畫
狒	狗	綠	留	媽	艹
士	補	馬	橙	釘	哥
雞	筆	行	衙	鑱	乘
朋	按	鼻	夭	糊	已

Response Lists

又	戶	困	舞	真	教	火
加	巴	向	居	丁	白	未
飛	先	說	今	飯	侵	松
肚	狹	譜	驚	停	字	找
好	笨	兵	手	細	口	喜
千	給	黃	兔	脚	之	赤
計	丑	話	道	木	由	心
樹	江	閒	圖	力	人	子
風	且	森	住	報	雪	回
肉	彷	錶	悄	吹	塗	單
有	吵	震	替	畫	水	父
佩	九	母	套	拉	青	流
土	釘	保	帽	兄	橘	馬
看	不	走	雞	乖	衙	鐵
避	紙	明	按	夫	糊	已

Appendix 3

Stimulus	Visual distractor	Stimulus	Phonological distractor	Stimulus	Semantic distractor
half	ball	kite	height	move	go
tile	lite	nose	knows	rob	steal
bard	drab	eight	ate	pit	hole
hall	bail	eye	I	clock	watch
call	calf	weigh	way	city	town
ail	all	know	no	auto	car
two	dad	chews	juice	right	true
tow	pep	vice	fights	stone	rock
aim	alm	axe	hacks	job	work
sung	snug	use	youths	look	see
mite	time	phone	foam	dime	coin
burn	hum	one	won	child	baby

Appendix 4

ENGLISH WORD RECOGNITION TEST

Stimulus lists	Response lists
1. kite desk news half	she ball disk height news
2. not free move sad	free books go sad not
3. rob jade tile bone	jade now steal lite bone
4. pit need soup clock	soup need hole my watch
5. soon city deed one	soon nine won town deed
6. nose bug shell eight	shell knows bug few ate
7. bard up seal eye	most up I seal drab
8. auto moon shout hall	car bail shout tap moon
9. on feed some hop	some on feed hop young
10. toast right green will	green will true toast hunt
11. gold weigh shop call	man calf shop way gold
12. egg know tree ail	egg tree no all class
13. goal pad chews vice	goal fights juice hill pad
14. two dad hug fair	hug in fair tow pep
15. yes axe stone aim	hacks rock yes alm put
16. use phone job ship	fly foam ship youths work
17. look crack sung mite	crack dues see time snug
18. dime child burn went	went hum coin baby flash